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Distribution of anionic and nonionic surfactants in a sewage-impacted Mediterranean coastal lagoon: Inputs and seasonal variations

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HIGHLIGHTS

- Surfactant fluxes in El Albujón watercourse show a marked seasonal variability.
- Maximum annual inputs (>400 kg) to Mar Menor lagoon were for LAS and SPC.
- LAS, AEO and NPEO levels were higher in samples collected near the lagoon shore.
- Surfactant concentrations in seawater were lower in summer than in other seasons.

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ABSTRACT

In this work we have monitored the seasonal inputs, occurrence and distribution of the world's most widely used surfactants (linear alkylbenzene sulfonates, LAS, nonylphenol polyethoxylates, NPEOs, and alcohol polyethoxylates, AEOs) in Mar Menor lagoon (SE Spain) and its main tributary (El Albujón) for the first time. Concentration of target compounds was determined in both surface waters and sediments after solid phase extraction and pressurized liquid extraction, respectively, followed by liquid chromatography–mass spectrometry (LC–MS). There were significant differences in surfactant fluxes from El Albujón towards Mar Menor depending on the season and the day of the week, with maximum estimated annual inputs being detected for LAS (406 kg) and their metabolites, sulfophenyl carboxylic acids (482 kg). Average concentrations of surfactants in the lagoon were between 44 and 1665 μg/kg in sediment, and between 0.3 and 63 μg/L in water. These levels were significantly higher for samples collected near the shore than for those measured inside the lagoon itself. Overall, the occurrence and distribution of surfactants in the system could be explained due to a combination of different sources (surface and groundwater inputs, treated and untreated wastewater effluents, towns, ports, etc.) and simultaneous in-situ physicochemical and biological processes, with an special emphasis on degradation during warmer months.

1. Introduction

Synthetic surfactants comprise a broad group of organic compounds that are used in large quantities as active ingredients of household and industrial detergents, as well as in the formulation of personal care products, pesticides and pharmaceuticals, among other applications (Ying, 2006). These compounds can be classified, according to their charge, into several main groups, where those of the anionic and nonionic classes account for the highest production volumes. Thus, the European Committee of Organic Surfactants and their Intermediates (CESIO) reported that 1200 kt of anionic and 1400 kt of nonionic surfactants were manufactured in Europe during the year 2010, which together represent for about 90% of the total European production of synthetic surfactants. Alcohol polyethoxylates (AEOs) are the most representative nonionic surfactants (e.g., 747 kt in Europe in 2000), followed by alkylphenol polyethoxylates (APEOs) and the anionic linear alkylbenzene sulfonates (550 kt both together). Widely used in household and laundry detergents, hand dishwashing liquids, shampoos, and other personal care products (Linear Alkylbenzene Sulfonate, LAS, 2009a), linear alkylbenzene sulfonates (LAS) are commercially available as a mixture containing homologues with alkyl chains ranging from 10 to 14 carbon units, and isomers resulting from the different attachment positions of the phenyl group along that chain. Commercial AEOs consist of a mixture of homologues typically having from 12 to 18 carbon atoms in their alkyl chain, which is bonded to a varying number of ethoxylate (EO) units. NPEOs (nonylphenol polyethoxylates, which

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